

CLAIMS

What is claimed is:

1. A method comprising:
receiving a multi-resolutional representation of an original pixel image; and
performing halftoning on the multi-resolutional representation in the wavelet division to produce an output operational image, including
quantizing multiresolutional coefficients, and
passing one or more error values onto one or more other multiresolutional coefficients.
2. The method defined in Claim 1 wherein the multiresolutional representation comprises a pyramidal decomposition of the image.
3. The method defined in Claim 1 wherein the multiresolutional representation comprises a two dimensional (2D) wavelet decomposition of the image.
4. The method defined in Claim 1 wherein the multiresolutional representation comprises a time-frequency decomposition of the image.
5. The method defined in Claim 1 further comprising converting the original pixel image into the multiresolutional representation of the image.

6. The method defined in Claim 1 further comprising scaling coefficients so coefficients contain the total energy of the region they represent.
7. The method defined in Claim 1 further comprising performing increased scaling of difference coefficients for enhanced edges in the halftone.
8. The method defined in Claim 1 further comprising applying an error filter to the multiresolutional coefficients, including changing the error filter depending on the multiresolution level of an error-producing coefficient.
9. The method defined in Claim 1 further comprising applying an error filter to the multiresolutional coefficients, and wherein the error filter is different or adaptive depending on the directional subband represented by the error-producing coefficient.
10. The method defined in Claim 1 further comprising applying an error filter to the multiresolutional coefficients, and wherein the error filter is adaptive based on both the multiresolution level of the error-producing coefficient and the directional subband represented by the error-producing coefficient.

11. The method defined in claim 1, wherein receiving the multiresolutional representation of the original pixel image includes arranging the multiresolutional coefficients to represent a spatial dependence of each multiresolutional coefficient.
12. An apparatus comprising:
- means for receiving a multi-resolutional representation of an original pixel image; and
 - means for performing halftoning on the multi-resolutional representation in the wavelet division to produce an output operational image, including
 - means for quantizing multiresolutional coefficients, and
 - means for passing one or more error values onto one or more other multiresolutional coefficients.
13. The apparatus defined in Claim 12 wherein the multiresolutional representation comprises a pyramidal decomposition of the image.
14. The apparatus defined in Claim 12 wherein the multiresolutional representation comprises a two dimensional (2D) wavelet decomposition of the image.
15. The apparatus defined in Claim 12 wherein the multiresolutional representation comprises a time-frequency decomposition of the image.

16. The apparatus defined in Claim 12 further comprising means for converting the original pixel image into the multiresolutional representation of the image.

17. The apparatus defined in Claim 12 further comprising means for scaling coefficients so coefficients contain the total energy of the region they represent.

18. The apparatus defined in Claim 12 further comprising means for performing increased scaling of difference coefficients for enhanced edges in the halftone.

19. The apparatus defined in Claim 12 further comprising means for applying an error filter to the multiresolutional coefficients, including means for changing the error filter depending on the multiresolution level of an error-producing coefficient.

20. The apparatus defined in Claim 12 further comprising means for applying an error filter to the multiresolutional coefficients, and wherein the error filter is different or adaptive depending on the directional subband represented by the error-producing coefficient.

21. The apparatus defined in Claim 12 further comprising means for applying an error filter to the multiresolutional coefficients, and wherein the error filter is adaptive based on both the multiresolution level of the error-producing coefficient and the directional subband represented by the error-producing coefficient.

22. The apparatus defined in Claim 12, wherein the means for receiving the multiresolutional representation of the original pixel image includes means for arranging the multiresolutional coefficients to represent a spatial dependence of each multiresolutional coefficient.

23. An article of manufacture comprising one or more recordable media containing executable instructions that, when executed by a machine, cause the machine to:

receive a multi-resolutional representation of an original pixel image; and

perform halftoning on the multi-resolutional representation in the wavelet division to produce an output operational image by

quantizing multiresolutional coefficients, and

passing one or more error values onto one or more other multiresolutional coefficients.

24. The article of manufacture defined in Claim 23 further comprising instructions which, when executed by the machine, cause the machine to convert the original pixel image into the multiresolutional representation of the image.

25. The article of manufacture defined in Claim 23 further comprising instructions which, when executed by the machine, cause the machine to scale coefficients so coefficients contain the total energy of the region they represent.

26. The article of manufacture defined in Claim 23 further comprising instructions which, when executed by the machine, cause the machine to perform increased scaling of difference coefficients for enhanced edges in the halftone.

27. The article of manufacture defined in Claim 23 further comprising instructions which, when executed by the machine, cause the machine to apply an error filter to the multiresolutional coefficients, including change the error filter depending on the multiresolution level of an error-producing coefficient.

28. An apparatus comprising:

- a transform;
- an arranger coupled to the transform; and
- an error diffusion unit coupled to the arranger to perform halftoning on the multi-resolutional representation in the wavelet division to produce an output operational image, wherein the error diffusion unit includes
 - a quantizer to quantize multiresolutional coefficients, and
 - a filter to pass one or more error values onto one or more other multiresolutional coefficients.

29. The apparatus defined in Claim 28 wherein the error filter is changed depending on the multiresolutional level of an error-producing coefficient.

30. The apparatus defined in Claim 28 wherein the error filter is changed depending on the directional subband represented by the error-producing coefficient.

31. A method comprising:
receiving a multiresolutional representation of an image; and
creating a halftone using error propagation without inverting the multiresolutional representation of the image.

32. An apparatus comprising:
means for receiving a multiresolutional representation of an image; and
means for creating a halftone using error propagation without inverting the multiresolutional representation of the image.

33. An article of manufacture comprising one or more recordable media containing executable instructions that, when executed by a machine, cause the machine to:
receive a multiresolutional representation of an image; and
create a halftone using error propagation without inverting the multiresolutional representation of the image.

34. A method comprising:
receiving a multiresolutional representation of an image; and
creating a halftone using error propagation without inverting the
multiresolutional representation of the image.
35. An apparatus comprising:
means for receiving a multiresolutional representation of an image; and
means for creating a halftone using error propagation without inverting the
multiresolutional representation of the image.
36. An article of manufacture comprising one or more recordable media containing
executable instructions that, when executed by a machine, cause the machine to:
receive a multiresolutional representation of an image; and
create a halftone using error propagation without inverting the multiresolutional
representation of the image.
37. A method comprising:
receiving a pixel domain representation of an image; and
performing halftoning that includes quantizing and error passing that is non-
causal with respect to the pixel domain.

38. A method comprising:
receiving an image as a pixel representation;
converting the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients;
iteratively quantizing each multiresolutional coefficient and passing an error to other multiresolutional coefficients on the same level as specified by an error filter; and
outputting a resulting quantized image.

39. The method defined in claim 38, wherein converting the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients includes arranging the multiresolutional coefficients to represent a spatial dependence of each multiresolutional coefficient.

40. The method defined in claim 38, wherein converting the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients includes scaling the multiresolutional coefficients to contain a total energy of a region represented by each multiresolutional coefficient.

41. The method defined in claim 38, wherein quantizing each multiresolutional coefficient comprises changing the error filter depending on a multiresolutional level represented by a multiresolutional coefficient creating the error.

42. The method defined in claim 38, wherein iteratively quantizing each multiresolutional coefficient and passing an error to other multiresolutional coefficients as specified by an error filter includes passing the error to neighboring multiresolutional coefficients of a same scale.

43. An article of manufacture comprising one or more recordable media containing executable instructions that, when executed by a machine, cause the machine to:

receive a multi-resolutional representation of an original pixel image; and

perform halftoning on the multi-resolutional representation in the wavelet

division to produce an output operational image, by

quantizing multiresolutional coefficients, and

passing one or more error values onto one or more other multiresolutional coefficients.

44. The article of manufacture of claim 43, further comprising instructions which, when executed by the machine, cause the machine to convert the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients includes arranging the multiresolutional coefficients to represent a spatial dependence of each multiresolutional coefficient.

45. The article of manufacture of claim 43, further comprising instructions which, when executed by the machine, cause the machine to convert the image from a pixel

representation to a multiresolutional representation having multiresolutional coefficients includes scaling the multiresolutional coefficients to contain a total energy of a region represented by each multiresolutional coefficient.

46. The article of manufacture of claim 43, wherein the error filter is adapted to a multiresolutional level represented by a multiresolutional coefficient creating the error.

47. The article of manufacture of claim 43, further comprising instructions which, when executed by the machine, cause the machine to iteratively quantize each multiresolutional coefficient and passing an error to spatially neighboring multiresolutional coefficients as specified by an error filter includes passing the error to neighboring multiresolutional coefficients of a same scale.

48. An image duplication device comprising:

- a receiving unit to receive an image as a pixel representation;
- a processing unit coupled with the receiving unit, the processing unit to convert the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients and to iteratively quantize each multiresolutional coefficient and pass an error to other multiresolutional coefficients as specified by an error filter; and
- an outputting unit coupled with the processing unit to output a resulting quantized image.

49. The image duplication device of claim 22, wherein the processing unit, in order to convert the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients, is to arrange the multiresolutional coefficients to represent a spatial dependence of each multiresolutional coefficient.

50. The image duplication device of claim 22, wherein the processing unit, in order to convert the image from a pixel representation to a multiresolutional representation having multiresolutional coefficients, is to scale the multiresolutional coefficients to contain a total energy of a region represented by each multiresolutional coefficient.

51. The image duplication device of claim 22, wherein the error filter is adapted to a multiresolutional level represented by a multiresolutional coefficient creating the error.

52. The image duplication device of claim 22, wherein the processing unit, in order to iteratively quantize each multiresolutional coefficient and pass an error to spatially neighboring multiresolutional coefficients as specified by an error filter, is to pass the error to neighboring multiresolutional coefficients of a same scale.